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FIELD OF VISION AND SIMPLE REACTION TIME DURING RECREATION EXERCISES AT WORK

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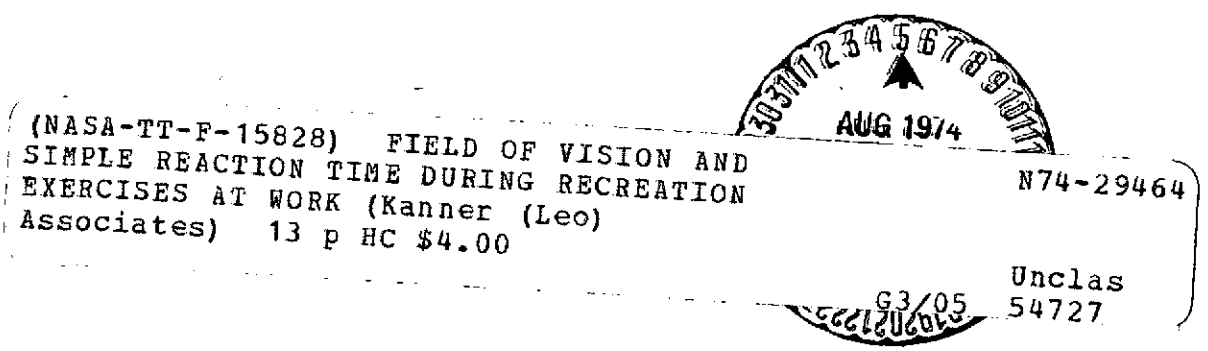

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16. Abstract Measurements were made of the simple reaction time to sound and light stimuli and of the field of vision with respect to different colors in female telephone exchange operators performing and not performing recreation exercises during break periods. After 5 months, the simple reaction to both stimuli turned out to be shorter in the exercising group than in the control group. The loss in the field of vision with respect to the test colors was also smaller in the exercising group. The practice of recreation exercises increased the efficiency of the nerve centers and of the sight analyzer in the cerebral cortex.

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FIELD OF VISION AND SIMPLE REACTION TIME DURING RECREATION EXERCISES AT WORK

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The work of female telephone operators involves the continuous observation of light signals of different colors on the switchboard panel. This requires a high degree of attention, causing considerable fatigue among the female telephone operators, which is reflected in a drop in productivity, a larger number of errors, wrong telephone connections, errors in calculating the telephone conversation times and certain psychic changes (nervousness, excessive irritability, cantankerousness). /413*

On the whole, while the technical factor involved in the work in various professions has been thoroughly studied, the human factor, the physiological processes that occur during the work, the fatigue and the psychic changes became only recently the object of specific studies. W. Missiuro and his collaborators [8, 9] devoted a particularly great deal of attention to specific work conditions in the modern industrialized and urbanized world.

It is known that, within the organism, the nerve centers are most prone to fatigue during work [10]. Therefore, fatigue reduces the precision of movements, the speed of the work, the productivity and increases the number of errors made. It follows that the study of fatigue processes that occur during work must primarily involve processes which occur in the nerve centers. The simple reaction time, which is the latent conditioned reflex movement time, can be studied to test the activity of the nerve centers. The state of different analyzers of the person

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* Numbers in the margin indicate pagination in the foreign text.

performing the work can also be used for such a test. In accordance with Pavlov's definition [11], by analyzers we shall mean not only the peripheral sensory organs, but also the corresponding nerve centers in the cerebral cortex together with the connecting nerves.

Because of the nature of their work, i.e. the necessity to react quickly to light signals of different colors, the study of the sight analyzer in telephone operators is extremely important.

It is known that fatigue causes losses in the field of vision with respect to various colors [1, 6]. Therefore, we decided to study the simple reaction time to a sound and light stimulus, and the field of vision with respect to various colors under the effect of fatigue and various forms of rest of the female telephone operator.

Active rest in the form of calisthenic exercises during /414
breaks is very effective in combatting the effects of fatigue. This was demonstrated 60 years ago by Syechenov in his classical experiments [13]. The stimulation of the nerve centers by means of calisthenic exercises contributes to the deeper inhibition of other centers and hence to their faster and more effective rest. In the Soviet Union, the United States and in other countries, studies were made of the dynamics of the fatigue process and the usefulness of short work breaks on perforated card machines, certain assembly line operations, in the foundry industry, in the textile industry and in many other industries. Studies were also made of the kind of calisthenic exercises and their intensity, which lead most rapidly to the normalization of the physiological processes in organisms engaged in various occupations.

Method

The authors measured in 114 female telephone operators the simple reaction time to sound and light and the field of vision with respect to the following colors: white, blue, yellow, red and green, in the period before the recreation exercises were introduced, before and after the work. Next, during the break, 10-minute recreation exercises were conducted daily with a group consisting of 57 female telephone operators. The remaining 57 female telephone operators did not participate in the exercises, and they were used as the control group. After 5 months, the simple reaction time and the field of vision with respect to various colors were measured again under the same conditions in the exercising and control groups. The simple reaction time was measured with the aid of the D'Arsonvalle apparatus with an accuracy up to 0.01 sec. The field of vision was measured with the aid of a perimeter.

Before the recreation exercises were introduced, observations were made of the work of the female telephone operators in order to select the proper exercises for them. The calisthenic exercises were performed after 2 hours of work, and they lasted about 8 min. The remaining 6-7 min of the break were spent walking and returning to a separate room or in fresh air, and preparing for work. Thus, the total break lasted 15 min.

The following exercises were used: 1) shoulder or leg exercises, 2) stretching exercises, 3) strenuous leg exercises, 4) trunk exercises, 5) warm-up exercises, 6) special exercises, 7) relaxation exercises.

During the exercises, particular attention was paid to the relaxation exercises after each exercise. In the beginning, the ability to relax the muscles caused greater difficulties to the female telephone operators than the mastery of the exercises

themselves. Only after about 1 month of exercises they were able to effectively apply the recommended type of relaxation exercises. By relaxing one group of muscles and, after the next exercises, another group of muscles, the regeneration of strength was considerably accelerated. These exercises counteract the small static tensions that occur during the work and, in this manner, enhance the elimination of the effects of fatigue [4].

The work of the female telephone operators has a sedentary character; the manipulations at the switchboard are carried out under strenuous attention, concentration and during constant conversations. An attempt was made to select soothing harmonious /415
elements in the exercises contrasting the working conditions. The calisthenics were performed in a room intended for rest, always with open windows or in fresh air, without musical accompaniment. An attempt was made to introduce a buoyant, cheerful, but not noisy, mood. Often, elements of relaxation exercises patterned on those used in Sweden, that were specially designed for female postal workers and secretaries, were integrated into the exercises [2, 7].

During the recreation exercises, particular attention was given to:

1) arm and leg exercises -- first simple leg exercises. After the mastery of slack swinging without static tension in the muscles, smooth swinging and dynamic arm exercises with slight tension were also introduced.

2) stretching exercises -- always with dynamic arm movements. Natural movements were performed in the well-planned exercises, often jointly with twisting and bending of the trunk.

3) the strenuous leg exercises -- performed to improve blood circulation. These were often knee bends, sometimes fast marches,

running or jumps. After the basic forms were mastered, they were performed jointly with the shoulder exercises. Great attention was given to foot exercises, which prevent (in addition to the sedentary work) platypodia and the formation of varicose veins.

4) trunk exercises -- performing forward, back and side bends, twists and combined twists and bends. An attempt was made to retain, as much as possible, all the natural joint movements. Attention was given to keeping a proper posture and strenghtening of the stomach and back muscles.

5) warm-up exercises -- in the form of motor amusements, sometimes games (in the yard), and also elements of dances and dances, for example, a waltz, a folk dance, or polka steps. However, measures were taken to prevent fatigue resulting from these elements. After strenuous exercises, for example, after polka jumps, gentle folk dance elements were performed.

6) special exercises -- used as coordination exercises (easy forms first). These exercises have a beneficial effect on motor coordination conditioning. They require a certain motor skill, since attention must be shifted from one movement to another during the exercises. These exercises were abandoned when the movements became automatic, since they no longer had an effect on motor coordination in the conditioning sense. These groups of exercises also included motor elements, whose purpose was to counteract the possible deformation of the spinal column resulting from the working position of the female telephone operators. The character of the exercises counteracted the movements made during work. Wrist and finger exercises were often performed, since they are continuously busy when the telephone connections are made.

7) the relaxation exercises -- whose purpose was to provide a gradual transition to rest after the 8-min exercises. Mild

forms of exercises were used, and relaxation elements associated with respiratory exercises were often introduced.

Results and Discussion

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The studies made by us demonstrated that the simple reaction time to a sound and light stimulus increases among the female telephone operators with increasing fatigue. The table presented below illustrates this relationship (Table 1).

TABLE 1. SIMPLE REACTION TIME AMONG THE FEMALE TELEPHONE OPERATORS THAT WERE STUDIED

Group	No. of telephone operators studied	Simple reaction time (mean)			
		light stimulus		sound stimulus	
		before work	after work	before work	after work
Control group	114	0.27	0.29	0.30	0.34
Exercising group	57	0.26	0.25	0.27	0.25
Nonexercising group	57	0.29	0.31	0.31	0.33

The statistical analysis of the results that were obtained at the beginning of the study has shown that the difference in the simple reaction time to both a light and a sound stimulus was not significant. For a light stimulus the value of the t test statistic was $t = 0.98$, which for $k = n_2 - 2 = 112$ degrees of freedom (d.f.) gives a probability $P \leq 0.317$ that the difference is due to random variation in the sample. For the sound stimulus, the values were respectively $t = 1.08$, $k = 112$, $P \leq 0.271$. It is well known that in biological experiments, a difference is considered to be significant only when $P \leq 0.05$.

A comparison of the same groups after 5 months in which the recreation exercises were introduced during the breaks has shown that the simple reaction time to both stimuli is considerably shorter in the exercising group than in the control group even

before the work begins. The statistical analysis showed that the difference was significant (for a light stimulus, $t = 4.3$, $k = 112$ d.f., $P \leq 0.0001$. This shows that the difference between the simple reaction time in the exercising group and the control group is significant. For the sound stimulus, the values were respectively $t = 2.5$, $k = 112$ d.f., $P \leq 0.0124$. The difference between the two groups was not significant in the control (initial) period ($t = 0.78$, $k = 112$ d.f., $P \leq 0.43$). On the basis of the above, the conclusion can be made that recreation exercises performed in breaks have a favorable effect on the efficient functioning of motor nerve centers in the cerebral cortex. Similar results were obtained by Krapnicewa [5] and Zolina [15], who observed an increase in the reaction time with an increase in the work load. Pavlova [12], who studied the reaction time and the dynamics of higher nervous functions among workers servicing perforated card machines, found that short calisthenic breaks during work reduce the simple reaction time and increase work productivity.

When the simple reaction time to sound and light stimulus in the exercising and nonexercising (control) group was compared, it became evident that the difference between the groups was significant at a high level. The difference between the simple reaction time before and after work is also significant at a high level. The simple reaction time to a light stimulus after work was 19.4% shorter in the exercising group than in the control group; /417 and the difference was statistically significant at the $P \leq 0.0001$ level. The simple reaction time to a sound stimulus after work was 24.3% shorter in the exercising group than in the control group (the difference was significant at the $P \leq 0.0003$ level).

Studies of the field of vision in the horizontal plane have shown that for all colors, for the left and right eye, it was reduced after the work in the following manner: with respect to white light among 73.3% of the persons studied, with respect to

blue light among 70% of the persons studied, with respect to yellow light among 75% of the persons studied, with respect to green light among 75.8% of the persons studied, and with respect to red light among 79.1% of the persons studied. After the recreation exercises were introduced, the loss in the field of vision after work was smaller in the exercising group than in the nonexercising group for all colors. Thus, for example, for the left eye in the exercising group, the horizontal angle for white color was decreased, on the average, after work, by 0.7°, for blue color by 0.8°, yellow color by 0.05°, and for red and blue [sic] color, it was increased respectively by 1.18° and 0.83°. In the control (nonexercising) group, the angle was decreased after work for all colors: for white color by 6°, blue color by 5.7°, yellow color by 6.6°, red color by 6.2°, and green color by 5.1°.

The statistical analysis demonstrated that the differences between the losses in the field of vision in the exercising and nonexercising groups were significant at a high level ($P \leq 0.01$) for all colors that were studied. Thus, the introduction of recreational exercises during breaks reduced the losses in the field of vision for all colors, which shows that they effectively counteract the fatigue of the sight analyzers.

Conclusions

1. The simple reaction time to a sound and light stimulus was increased after work among the female telephone operators. This increase can be considered as one fatigue indicator.

2. The simple reaction time to a light and sound stimulus after 5 months of recreation exercises during breaks was already decreased among the female telephone operators before the work began.

3. In contrast to the control group, in the group of exercising telephone operators, the simple reaction time after work did not increase -- it even decreased.

4. A loss in the field of vision with respect to all colors was observed after work.

5. In the exercising group, the loss in the field of vision with respect to all colors that were studied was smaller than in the control group.

6. The observed changes demonstrate the beneficial effect of recreation exercises on the efficient functioning of the motor nerve centers and the sight analyzer in the cerebral cortex.

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